California Institute for Regenerative Medicine

Evaluation of the mass transfer rate using computer simulation in a three-dimensional interwoven hollow fiber-type bioartificial liver.

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Public Summary:
This paper describes physical advantages of the hollow fiber-based interwoven-type bioreactor over a conventional dialyzer-type bioreactor. In addition, a computational simulation was performed to estimate parameters to operate a large (clinical) scale bioreactor.

Scientific Abstract:
OBJECTIVES: To determine the most efficient design of a hollow fiber-based bioreactor device for a bioartificial liver support system through comparative bioengineering evaluations. RESULTS: We compared two types of hollow fiber-based bioreactors, the interwoven-type bioreactor (IWBAL) and the dialyzer-type bioreactor (DBAL), by evaluating the overall mass transfer coefficient (K) and the convective coefficient (X). The creatinine and albumin mass transfer coefficients and convective coefficients were calculated using our mathematical model based on the homoporous theory and the modified Powell method. Additionally, using our model, we simulated the mass transport efficiency in clinical-scale BALs. The results of this experiment demonstrate that the mass transfer coefficients for creatinine and albumin increased proportionally with velocity with the IWBAL, and were consistently greater than that found with the DBAL. These differences were further enhanced in the simulation of the large-scale model. CONCLUSIONS: Our findings indicate that the IWBAL with its unique 30 degrees cross hollow fiber design can provide greater solute removal and more efficient metabolism when compared to the conventional DBAL design.

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